AMENDMENTS TO THE CLAIMS

The following is a complete, marked up listing of revised claims with a status identifier in parentheses, underlined text indicating insertions, and strikethrough and/or double-bracketed text indicating deletions.

LISTING OF CLAIMS

1. (CANCELED)

2. (CURRENTLY AMENDED) A method of forming a silicon oxide layer on a semiconductor substrate ~~according to claim 1, wherein forming the SOG layer further comprises~~comprising:

spin coating the semiconductor substrate with a SOG composition to form a SOG coating, the SOG composition including polysilazane dissolved in a first solvent;~~ and~~

heating the SOG coating to a temperature of not more than about 400 °C. for a soft bake time sufficient to evaporate substantially all of the first solvent from the SOG coating and thereby form the SOG layer; and

treating the SOG layer with an oxidant solution to convert the polysilazane to silicon oxide.

3. (CURRENTLY AMENDED) A method of forming a silicon oxide layer according to claim ~~1~~2, wherein the oxidant solution further comprises:

at least one oxidant selected from a group consisting of ozone, peroxides, permanganates, hypochlorites, chlorites, chlorates, perchlorates, hypobromites, bromites, bromates, hypoiodites, iodites, iodates, nitric acid and sulfuric acid.

4. (CURRENTLY AMENDED) A method of forming a silicon oxide layer according to claim ~~1~~2, wherein treating the SOG layer further comprises:

applying the oxidant solution to the SOG layer by dipping, spraying or puddling, the oxidant solution including an oxidant dissolved in a second solvent.

5. (ORIGINAL) A method of forming a silicon oxide layer according to claim 3, wherein the oxidant solution further comprises:

an aqueous solution of ozone, the concentration of ozone being between about 1 ppm and about 200 ppm.

6. (ORIGINAL) A method of forming a silicon oxide layer according to claim 3, wherein the oxidant solution further comprises:

an aqueous solution of ozone, the concentration of ozone being between about 5 ppm and about 100 ppm, the oxidant solution being applied to the SOG layer at a temperature of between about 20 °C. and about 40 °C.

7. (ORIGINAL) A method of forming a silicon oxide layer according to claim 3, wherein the oxidant solution further comprises:

an aqueous solution of hydrogen peroxide, the concentration of hydrogen peroxide being between about 0.5 weight percent and about 30 weight percent, the oxidant solution being applied to the SOG layer at a temperature of between about 25 °C. and about 90 °C.

8. (ORIGINAL) A method of forming a silicon oxide layer according to claim 7, wherein the oxidant solution further comprises:

an aqueous solution of ammonium hydroxide, the concentration of ammonium hydroxide being sufficient to establish a weight ratio with the concentration of hydrogen peroxide of between about 1:3 and 1:10.

9. (ORIGINAL) A method of forming a silicon oxide layer according to claim 3, wherein the oxidant solution further comprises:

an aqueous solution of hydrogen peroxide and ammonium hydroxide, the concentration of hydrogen peroxide being between about 3 weight percent and about 10 weight percent and the concentration of the ammonium hydroxide being between about 0.5 weight percent and about 5 weight percent, the oxidant solution being applied to the SOG layer at a temperature of between about 40 °C. and about 80 °C.

10. (ORIGINAL) A method of forming a silicon oxide layer according to claim 2, wherein:

the first solvent is an organic solvent;

and further wherein:

the SOG composition includes between about 5 weight percent and about 30 weight percent polysilazane.

11. (ORIGINAL) A method of forming a silicon oxide layer according to claim 10, wherein:

the first solvent is selected from a group of organic solvents consisting of aromatic solvents, aliphatic solvents and ether-type solvents;

and further wherein:

the first solvent is between about 70 weight percent and about 95 weight percent of the SOG composition.

12. (ORIGINAL) A method of forming a silicon oxide layer according to claim 11, wherein:

the first solvent includes at least one selected from the group consisting of toluene, benzene, xylene, dibutylether, diethylether, THF, PGME, PGMEA and hexane.

13. (ORIGINAL) A method of forming a silicon oxide layer according to claim 2, wherein forming the SOG layer further comprises:

further heating the SOG layer to a temperature between about 300 °C. and about 600 °C. for a hard bake time sufficient to densify the SOG layer.

14. (ORIGINAL) A method of forming a silicon oxide layer according to claim 13, wherein forming the SOG layer further comprises:

further heating the SOG layer to a temperature between about 300 °C and about 600 °C for a hard bake time sufficient to increase a HF etch resistance of the SOG layer by at least 50%.

15. (ORIGINAL) A method of forming a silicon oxide layer according to claim 2, wherein forming the SOG layer further comprises:

further heating the SOG layer to a temperature between about 300 °C. to about 500 °C. under an oxidizing atmosphere for a time period between about 10 and about 120 minutes to form a partially converted SOG layer including silicon dioxide and polysilazane; and

treating the partially converted SOG layer with an oxidant solution to covert substantially all remaining polysilazane into silicon dioxide and thereby form the silicon dioxide layer.

16. (ORIGINAL) A method of forming a silicon oxide layer according to claim 13, further comprising:

annealing the silicon oxide layer at a temperature of at least 600 °C. for an anneal time sufficient to form a densified silicon oxide layer.

17. (ORIGINAL) A method of forming a silicon oxide layer according to claim 16, further comprising:

planarizing the densified silicon oxide layer.

18. (ORIGINAL) A method of forming a silicon oxide layer according to claim 17, wherein planarizing the densified silicon oxide layer further comprises:

removing an upper portion of the densified silicon oxide layer using a dry etch, a wet etch or a chemical mechanical planarization (CMP).

19. (ORIGINAL) A method of forming a silicon oxide layer according to claim 17, wherein planarizing the densified silicon oxide layer further comprises:

removing an upper portion of the densified silicon oxide layer to expose an upper surface of the semiconductor substrate.

20. (ORIGINAL) A method of forming a silicon oxide layer according to claim 17, wherein planarizing the densified silicon oxide layer further comprises:

removing an upper portion of the densified silicon oxide layer to expose an upper surface of the semiconductor substrate using a CMP process; and

etching the silicon oxide layer to produce an oxide surface that is recessed relative to the upper surface of the semiconductor substrate.

21. (CURRENTLY AMENDED) A method of forming a silicon oxide layer according to claim ~~1~~2, wherein:

the semiconductor substrate includes a pattern.

22. (ORIGINAL) A method of forming a silicon oxide layer according to claim 21, wherein:

the pattern includes a conductive material.

23. (ORIGINAL) A method of forming a silicon oxide layer according to claim 22, wherein:

the conductive material includes tungsten (W) or tungsten silicide (WSi_x).

24. (ORIGINAL) A method of forming a silicon oxide layer according to claim 22, wherein:

the conductive material includes aluminum or copper.

25 (ORIGINAL) A method of forming a silicon oxide layer according to claim 21, wherein:

the pattern includes recesses formed in the semiconductor substrate.

26. (ORIGINAL) A method of forming a silicon oxide layer according to claim 25, wherein:

the pattern includes shallow trench isolation (STI) openings formed in the semiconductor substrate.

27. (ORIGINAL) A method of manufacturing a semiconductor device comprising:

forming a SOG layer on a semiconductor substrate, the SOG layer including a polysilazane; and

treating the SOG layer with an oxidant solution to convert the polysilazane to silicon oxide.

28. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 27, further comprising:

forming isolation trench structures on the semiconductor substrate;

filling the isolation trench structures with the SOG layer; and

removing an upper portion of the silicon oxide to expose a surface of the semiconductor substrate.

29. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 27, further comprising:

forming gate electrode structures on the semiconductor substrate;

covering the gate electrode structures with the SOG layer;

forming openings in the silicon oxide to expose portions of the gate electrode structures; and

depositing a first metal layer on the silicon oxide.

30. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 27, further comprising:

forming a first conductive pattern on the semiconductor substrate;

covering the first conductive pattern with the SOG layer;

forming openings in the silicon oxide to expose portions of the first conductive pattern; and

depositing a second conductive layer on the silicon oxide.

31. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 27, further comprising:

forming a pattern on the semiconductor substrate, the pattern including recessed portions;

covering the pattern and filling the recessed portions with the SOG layer; and

removing an upper portion of the silicon oxide to expose a surface of the semiconductor substrate.

32. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 31, further comprising:

removing an additional portion of the silicon oxide to form an oxide surface in the recessed portion, the oxide surface being recessed relative to the surface of the semiconductor substrate.

33. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 32, wherein:

removing an upper portion of the silicon oxide is achieved using an etchback process or a CMP process; and

removing the additional portion of the silicon oxide is achieved an etchback process.

34. (ORIGINAL) A method of manufacturing a semiconductor device comprising:

forming isolation trench structures on the semiconductor substrate;

filling the isolation trench structures with a first SOG layer, the first SOG layer including a polysilazane;

treating the first SOG layer with a first oxidant solution to form a first silicon oxide layer;

removing an upper portion of the first silicon oxide layer to expose a surface of the semiconductor substrate;

forming gate electrode structures on the surface of the semiconductor substrate;

covering the gate electrode structures with a second SOG layer, the second SOG layer including a polysilazane;

treating the second SOG layer with a second oxidant solution to form a second silicon oxide layer;

forming contact openings in the second silicon oxide layer to expose portions of the gate electrode structures;

forming a first conductive pattern on the second silicon oxide layer;

covering the first conductive pattern with á third SOG layer, the third SOG layer including a polysilazane;

treating the third SOG layer with a third oxidant solution to form a third silicon oxide layer;

forming via openings in the third silicon oxide layer to expose portions of the first conductive pattern; and

forming a second conductive pattern on the third silicon oxide layer.

35. (ORIGINAL) A method of manufacturing a semiconductor device according to claim 34, wherein:

each of the oxidant solutions includes at least one oxidant selected from a group consisting of ozone, peroxides, permanganates, hypochlorites, chlorites, chlorates, perchlorates, hypobromites, bromites, bromates, hypoiodites, iodites, iodates, nitric acid and sulfuric acid.

36. (ORIGINAL) A method of forming a silicon oxide layer on a semiconductor substrate comprising:

forming a spin-on-glass (SOG) layer on the semiconductor substrate, the SOG layer including polysilazane;

baking the spin-on-glass layer to partially convert the polysilazane to silicon oxide; and

treating the SOG layer with an oxidant solution to convert remaining polysilazane to silicon oxide, thereby forming the silicon oxide layer.

37. (ORIGINAL) A method of forming a silicon oxide layer according to claim 36, wherein forming the SOG layer further comprises:

spin coating the semiconductor substrate with a SOG composition to form a SOG coating, the SOG composition including polysilazane dissolved in a first solvent; and

heating the SOG coating to a temperature of not more than about 400 °C. for a time sufficient to evaporate substantially all of the first solvent from the SOG coating and thereby form the SOG layer.

38. (ORIGINAL) A method of forming a silicon oxide layer according to claim 36, wherein the oxidant solution further comprises:

at least one oxidant selected from the group consisting of ozone, peroxides, permanganates, hypochlorites, chlorites, chlorates, perchlorates, hypobromites, bromites, bromates, hypoiodites, iodites, iodates, nitric acid and sulfuric acid.

39. (ORIGINAL) A method of forming a silicon oxide layer according to claim 36, wherein treating the SOG layer further comprises:

applying the oxidant solution to the SOG layer by dipping, spraying or puddling, the oxidant solution including an oxidant dissolved in a second solvent.

40. (ORIGINAL) A method of forming a silicon oxide layer according to claim 38, wherein the oxidant solution further comprises:

an aqueous solution of ozone, the concentration of ozone being between about 5 ppm and about 100 ppm, the oxidant solution being applied to the SOG layer at a temperature of between about 20 °C. and about 40 °C.

41. (ORIGINAL) A method of forming a silicon oxide layer according to claim 38, wherein the oxidant solution further comprises:

an aqueous solution of hydrogen peroxide, the concentration of hydrogen peroxide being between about 0.5 weight percent and about 30 weight percent, the oxidant solution being applied to the SOG layer at a temperature of between about 25 °C. and about 90 °C.

42. (ORIGINAL) A method of forming a silicon oxide layer according to claim 37, wherein:

the first solvent is an organic solvent;

and further wherein:

the SOG composition includes between about 5 weight percent and about 30 weight percent polysilazane.

43. (ORIGINAL) A method of forming a silicon oxide layer according to claim 42, wherein:

the first solvent includes at least one selected from the group consisting of toluene, benzene, xylene, dibutylether, diethylether, THF, PGME, PGMEA and hexane.

44. (ORIGINAL) A method of forming a silicon oxide layer according to claim 37, wherein:

the baking the spin-on-glass layer is conducted in an oxidizing atmosphere.

45. (ORIGINAL) A method of forming a silicon oxide layer according to claim 44, wherein:

the oxidizing atmosphere is an oxygen atmosphere or a water-vapor atmosphere.

46. (ORIGINAL) A method of forming a silicon oxide layer according to claim 45, further comprising:

annealing the silicon oxide layer at a temperature of at least 600 °C. for a time sufficient to form a densified silicon oxide layer.

47. (ORIGINAL) A method of forming a silicon oxide layer according to claim 46, further comprising:

planarizing the silicon oxide layer.

48. (ORIGINAL) A method of forming a silicon oxide layer according to claim 36, wherein:

the semiconductor substrate includes a pattern.

49. (ORIGINAL) A method of forming a silicon oxide layer according to claim 48, wherein:

the pattern includes a conductive material.

50. (ORIGINAL) A method of forming a silicon oxide layer according to claim 49, wherein:

the conductive material includes tungsten (W) or tungsten silicide (WSi_x).

51. (ORIGINAL) A method of forming a silicon oxide layer according to claim 48, wherein:

the pattern includes recesses formed in the semiconductor substrate.

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